Ch # Liquid

Properties:

* Volume:

definite => intermediate IMF

* Shape:

indefinite => IMF ⟶ weak.

* Avg K.E:

$K.E_{(avg)} \propto T$

* Kinetic gas Equation:

$PV = \frac{1}{3} m N V^2_{rms}$

m → mass, N → No. mole

$K.E_{(avg)} = \frac{3}{2} PV$

$K.E_{(avg)} = \frac{3}{2} nRT$

$(K.E_{(avg)} \propto n)$

independant of Nature of Gas

independant of state

5 Kg $H_2O_{(ice)}$ 5 Kg $H_2O_{(liq)}$ 5 Kg $H_2O_{(gas)}$

At 10°C

⇓

=> $K.E_{(avg)}$ = Same

=> K.E = different.

Liquid K.E(avg) = at B.P max K.E(avg)

* Viscosity:

Liquid & Gas

* Surface Tension:

only liquid

* Evaporation & B.P:

only liquid.

Forces

Intermolecular

* b/w the molecules

* physical force

effect physical properties

H. Bonding → directional

dipole dipole ← D.D.F

L.D.F → Vanderwaal force

Debye

ion dipole force

ion induced dipole

Intramolecule

* with in the molecules

chemical force

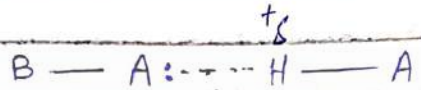
Covalent → directional

ionic

Co-ordinate

Metallic

H-Bonding



⇓

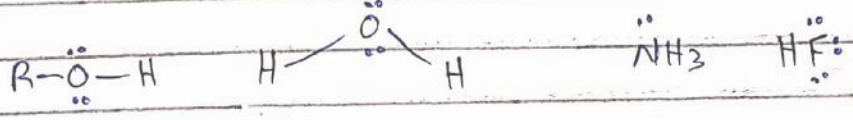
L·p ↯ partial +ve Hydrogen

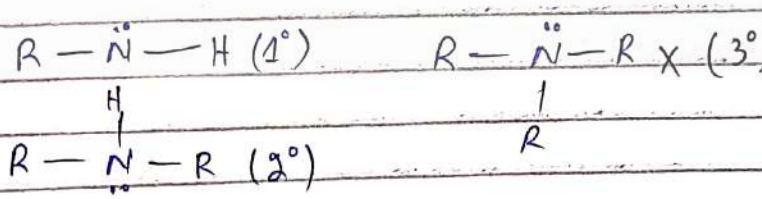
* electrostatic force.
* 20 times weaker than C·B
* Directional.

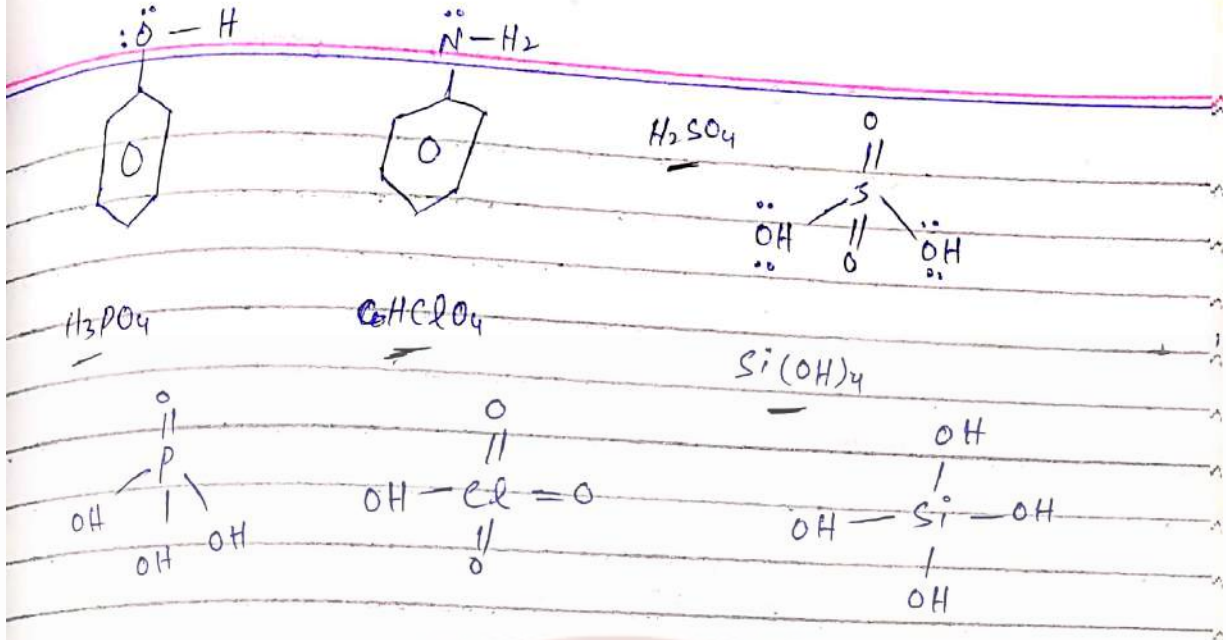
Condition:

* H → bonded to F, O, N
* L·p → present on F, O, N
  ↓ stable on high E·N element
* proper orientation

H·B in individual Molecules



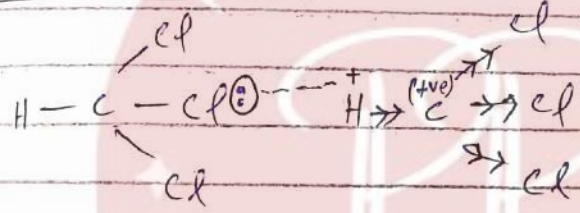




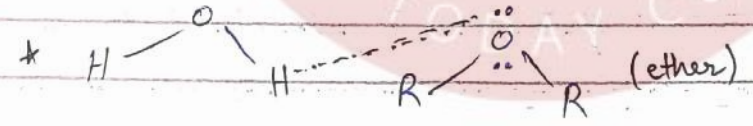
$\ddot{C}H_2$ → No H·B

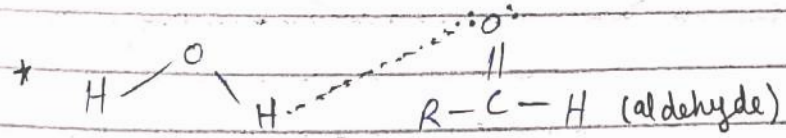
CHF_3 $CHCl_3$ → exceptional

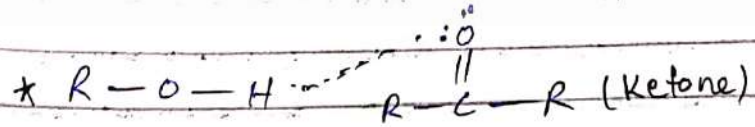
fluoro form



(#) H·B in Mixture

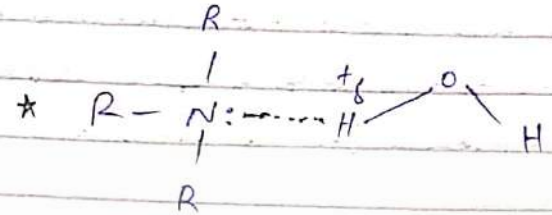






$CH_4 + H_2O$ → NO H·B

* H_2SO_4 in H_2O ✓ * $HClO_4$ in H_2O ✓



(3° amine)

Strength of H·B

✓ strength ∝ ΔE·N

$(HF > H_2O > NH_3)$ → strength of H·Bonding

✓ Strength ∝ B·A → ✓ strength ∝ concentration

✓ strength ∝ $\frac{1}{\text{dilute}}$ → ✓ strength ∝ $\frac{1}{T}$

✓ strength ∝ $\frac{1}{\text{distance}}$

Strength ∝ Solid > liquid > Gases

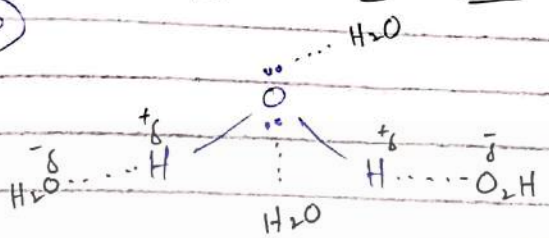
* 2(M) H_2O < 5M H_2O → b/c concentration is high.

2 moles/L

* 5Kg H_2O in 10 dm^3 < 5Kg H_2O in 5 dm^3

(#) NO # H-Bonding

H_2O

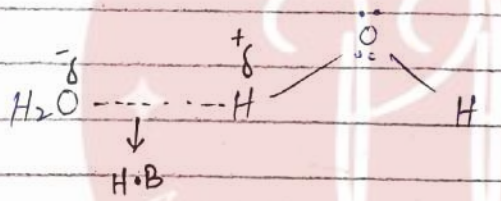


* Condense form of with Surrounding form = (4)

For 1 H·B ⟶ 1 L·P + 1 H

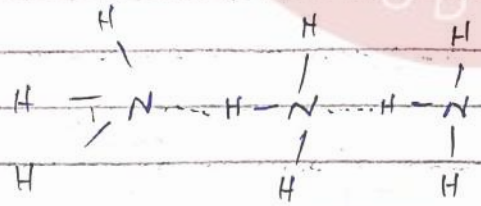
Capacity ← * Contribution or per molecule = (2)

* one H_2O with another H_2O = (1)



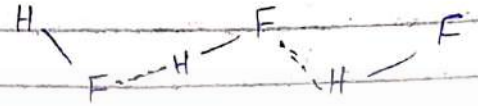
$\ddot{N}H_3$:

10 NH_3 ⟶ 10 L·P ⟶ 10 H·B
⟶ 30 H



* Surrounding ⟶ 02
* Capacity ⟶ 01
* with another NH_3 ⟶ 01

3) $H\ddot{\underset{\cdot\cdot}{F}}:$



* Surrounding = 02
* Capacity = 01
* with another HF = 01

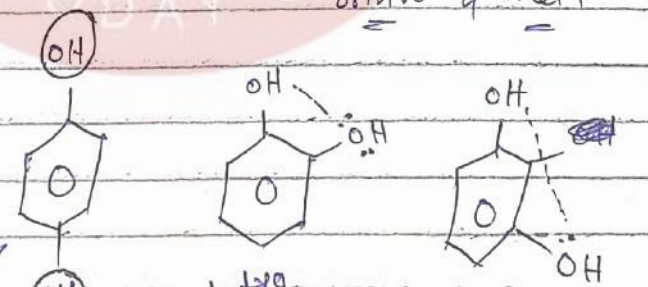
b/c cyclic tendency greater

(#) Types of H·B

Intermolecular H·B ⇓ H·B b/w two molecules

Intramolecular H·B ⇓ H·B b/w within the same molecules possible in cyclic (planner) Ring

possible at ortho & meta

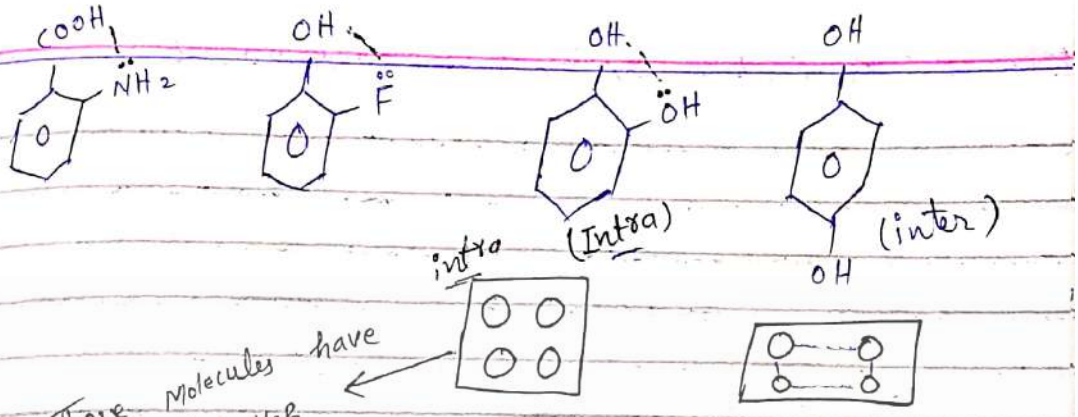


only inter

Intra

inter / intra (weak)

inter > intra



These molecules have used their H·B within the molecules therefore they are unable to form H·B with another molecule.

intra	inter
* Low B·P	* high B·P
* volatile	* less volatile
* V·P high	* Low v·pressure
* Low acidity	* high acidity
* Less stable	* stable

Dipole - Dipole Force

* b/w polar - polar.
* electrostatic force b/w +ve & -ve.
* $\mu \neq 0$

Q# In which one D-D force present.

a) CCl_4 & SO_2 b) $PCl_5 + SO_3$
c) Br_2 & NH_3 d) $SO_2 + PCl_3$

Strength:

strength $\propto \Delta E \cdot N$

strength $\propto \frac{1}{\text{Distance}}$

strength $\propto \frac{1}{T}$

strength $\propto$ solid > liquid > Gas

Q# Max D·D force in:

HF > HCl > HBr > HI

③ Debye Force

* Dipole ✓ induced dipole
* b/w polar & non-polar.
* $\mu = 0$ & $\mu \neq 0$

Q# ✓ Deby Force present in?

(a) SO_3 & SO_2 b) SO_2 & PCl_3

c) NH_3 & HCl d) All

Strength:

For polar:

* strength $\propto \Delta E.N$
* strength $\propto \frac{1}{\text{Distance}} \propto \frac{1}{\text{Temperature}}$

For Non-polar:

* strength $\propto$ Molar mass ✓ imp
* strength $\propto$ No # e^- (when m.mass same)
* strength $\propto$ No π bond

MCQs:

Deby Force max in

a) HCl & SO_3 (b) ✓ HCl & PCl_5 due to more molar mass.

c) HCl & Cl_2 d) Same

④ Ion-dipole Force

* Ion & polar molecule

a) NH_4^+ + HCl ($\mu = 0$) b) H_3O^+ + HCl ($\mu \neq 0$)

↓ in both present

* present in solution.

* amount of energy rise by ion-dipole interaction is called hydration energy

* H.E ⟶ exothermic

Strength:

For ion:

✓ strength ∝ charge

✓ strength ∝ $\frac{1}{\text{size}}$

Polar:

ion same ↓

strength ∝ ΔE.N

Q# Max D.D force present in

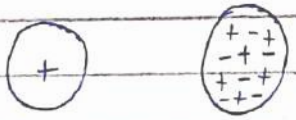
a) $Na^+ + H_2O$ b) $Mg^{+2} + H_2O$

c) $Al^{+3} + H_2O$ ✓

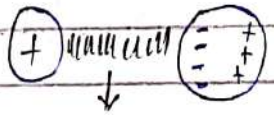
⑤ Ion-induced dipole

* Ion & Non-polar molecule

(μ=0)



ion Non-polar → charge distri same.



ion-dipole

* Ion:

Strength $\propto$ charge

Strength $\propto \frac{1}{\text{size}}$

* Non-polar:

Strength $\propto$ Molar mass.

⑥ LDF

Instantaneous

Sec Name ~~dipole~~ induced dipole forces.

* b/w Non-polar → size + es

Arise

* b/c of Size of Molecules

* present in all type of Molecules except (H^+)

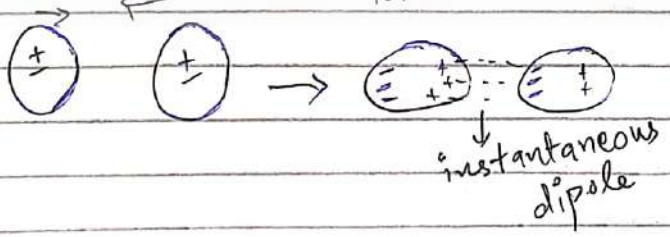
but dominant in Non-polar

Q# LDF may be present in?

a) H_2O b) HF c) NH_4^+ d) H^+ → repulsion present e) All a & b & c

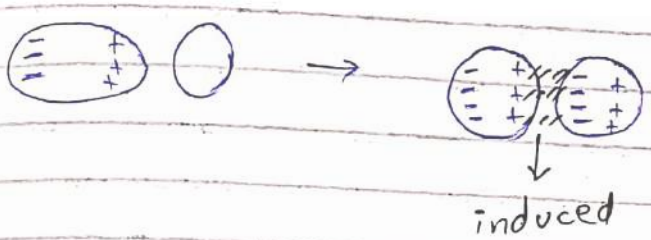
* Instantaneous dipole:

b/w Arise b/c of repulsion of es (Non-polar Molecules)



* Induced dipole:

instantaneous dipole created by dipole.



① Factors affecting LDF:

✓ LDF ∝ molar mass

✓ LDF ∝ Molecular size

LDF ∝ No# es̄ | LDF ∝ No π bonds.

Q# $F_2 < Cl_2 < Br_2 < I_2$

Q# $CH_3 < C_2H_6 < C_3H_8$

Strength: Generally

dipole induced dipole

Ion-dipole > H·B > DDF > ion-induced dipole > Debye > LDF

Q# Which one has max vander waal forces?

a) Al^{+3} + HCl (ion-dipole) ①

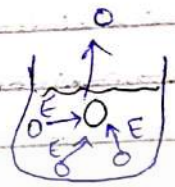
b) $CH_4 + O_2$ ④ → LDF

c) CH_4 + HCl ③ → dipole induced dipole

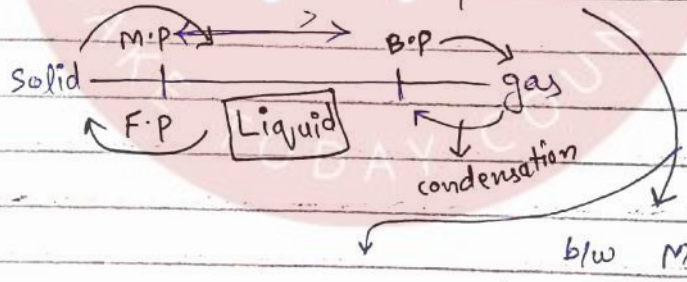
d) $NH_3 + NH_3$ (H·B) ②

(#) Evaporation

* Liquid ⟶ Gas



* Surface phenomena.
* endothermic
* Cause Cooling.
* Slow process.
* Spontaneous ⟶ always exothermic but except evaporation.
* phase transition process.
* Temperature of evaporating molecule ⇑
* ↳ ↳ liquid molecules ⇓
* phase transition process below the B.P
* extensive property ⟶ depend on amount of liquid
* Occur at all Temperature



b/w M.P & B.P

b/w F.P & condensation

Rate of evaporation

R.E.P ∝ T

↳ ↳ ∝ S.Area

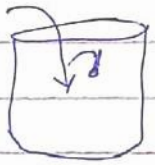
R.E.P ∝ liquid amount

REP $\propto \frac{1}{IMF} \propto \frac{1}{\text{No\#ions}}$

Priority 1

R·E·P $\propto$ molar mass > H-bonding

Rate of eva $\propto \frac{1}{\text{impurity}}$



R·E·P $\propto$ wind speed

R·E·P $\propto \frac{1}{\text{humidity}}$

* Evaporation depends on
  - ↳ property of liquid
  - only depend on liquid.
  - Eg: evaporation ہے، Eg: liquid ہے۔

Q# Which one has max rate of evaporation?

$F_2 > Cl_2 > Br_2 > I_2$

$H_2O < HF < NH_3 < CH_4$

$HF > SO_3 > I_2$

$CH_3F > CH_3Cl > CH_3Br > CH_3I$

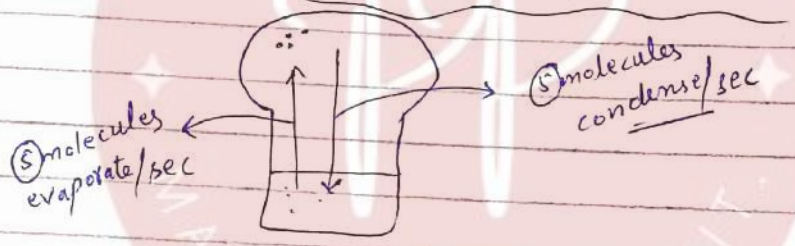
when external force ⇑

The pressure exerted by vapours of liquid when rate of evaporation becomes equal to rate of condensation. ← Vapor pressure

↳ evaporation rate ⇓

pressure of vapours on its own surface.

* pressure exerted at equilibrium
* define for closed container.
* N/m² ✓
* independant of
  - ✓ * Surface Area
  - ✓ * Amount of liquid
* (Rate of evaporation = Rate of condensation)



* intensive property.

Factor:

V.P ∝ Temperature

V.P ∝ 1/external pressure

V.P ∝ 1/impurity

V.P ∝ 1/IMF

① V.P ∝ 1/m.mass

② V.P ∝ 1/H.Bonding

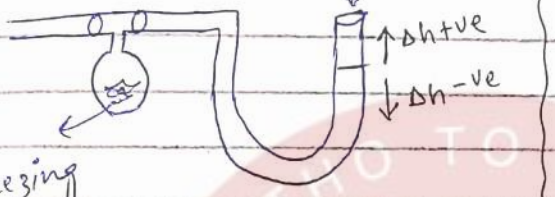
* $HCl > HBr > HI > HF$
* $F_2 > Cl_2 > Br_2 > I_2$

$5\,Kg\ H_2O = 10\,Kg\ H_2O$

$5\,Kg\ H_2O$ in $5\,cm^3$ vessel = $5\,Kg\ H_2O$ in $10\,cm^3$ vessel.

Measurement

Monometric method (most accurate method)



* No entraped air
* Non-volatile liquid used

$\Delta h = 0$:

$V.P_{(l)} = atm_p$

Δh = +ve :

$V.P_{(l)} > atm_p$

$V.P_{(l)} = atm + \Delta h$

Barometric method (Barometer)

Less accurate

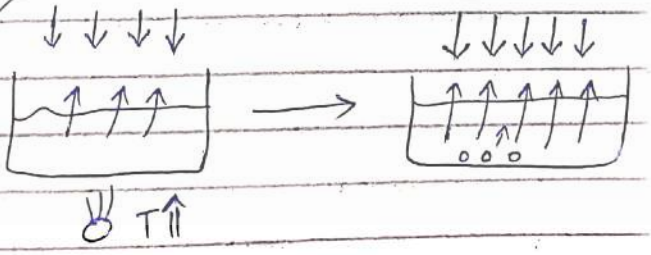
* entraped air
* volatile liquid used.

Δh = -ve :

$V.P_{(l)} < atm_p$

$V.P_{(l)} = atm - \Delta h$

Boiling Point



Temperature at

V.P = External pressure

unit: K, °F, °C

* endothermic process. * Non Spontaneous
* intensive property → independant of Amount of liq.
* Bulk phenomena.
* fast process.
* phase transition process.
* At B.P both Gas & liquid are at equilibrium.
* At B.P K.E (liquid) → max.
* At B.P K.E (gas) → indefinite.
* At B.P → Temperature same
  - depend on external pre
  - Energy is used to break bond

Factors:

- B.P $\propto \frac{1}{\text{evaporation}}$
- B.P $\propto \frac{1}{\text{V.pressure}}$
- B.P $\propto$ external pressure
- B.P $\propto \frac{1}{\text{height}}$
- B.P $\propto$ impurity

B.P → colligative property → B.P $\propto$ No. particles

depend on No. particles.

Max B.P ↑ ✓

0.1M Na_2SO_4 → $2Na^+ + SO_4^{-2}$

0.1M $AlCl_3$ → $Al^{+3} + 3Cl^-$ (4)

0.1M KCl → $K^+ + Cl^-$

polar

* B.P α H.B
* B.P α No # H.B
* B.P α E.N of C.at

Non-polar or polar

* B.P α M.mass
* B.P α $\frac{1}{\text{Branching}}$ for same group

priority:

B.P α IMF

B.P α H.B

B.P α No # H.B

B.P α E.N of C.atom

Same atomic mass

① B.P α Molar mass

② B.P α cyclic > Linear > Branch

B.P α $\frac{1}{\text{Branching}}$

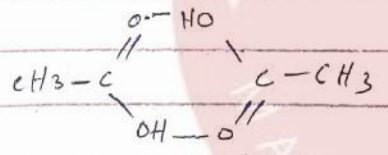
B.P α $\frac{1}{\text{volatility}}$

N-alkane > iso- > neo

$H_2O > HF > NH_3 > CH_4$

dimer form

$CH_3COOH > CCl_4 > CHCl_3$



HF HCl HBr HI

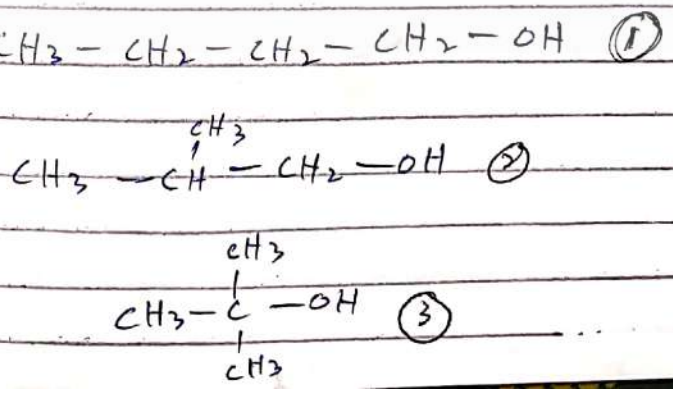
HF > HI > HBr > HCl

more volatile

Cyclohexane > n-hexane > iso-hexane

$C_6H_6 > CCl_4 > CH_4$

$HF < SO_3$



① $CH_3-CH_2-CH_2-CH_2-OH$

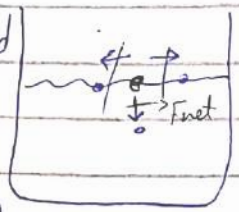
② $CH_3-CH(CH_3)-CH_2-OH$

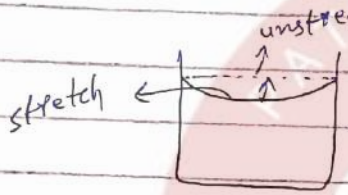
③ $CH_3-C(CH_3)_2-OH$

Surface Tension

The stretch membrane on surface of liquid.

The force applied by Anterior molecule on unit length of exterior molecule ⊥ is called surface Tension.





→ The work done to bring stretch area to unstretch area called surface Tension

Meniscus

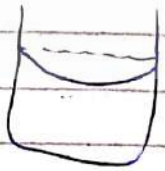
Cohesive: Forces b/w same molecules

Adhesive: Forces b/w different molecules

Convex Meniscus

Coh 7 > adh 7

Concave Meniscus



adh > Cohesive

wet surface area

↑

Wetting liquid:

Adh 7 > Coh 7

* Concave Meniscus

Non-wetting liquid:

Coh 7 > adh 7

Mercury → Metal → Metallic

* Convex Meniscus

New Lec

M. form:

$\gamma = \frac{F}{L}$ $\gamma = \frac{W}{A}$

unit = N/m or J/m^2

↑ independant of amount

↑ intensive

Stagnometer

Factors:

* S.T ∝ IMF
* S.T ∝ H.B
* S.T ∝ M.mass
* S.T ∝ $\frac{1}{Temp}$
* $\gamma = 0$ at Tc

* S.T ∝ density
* S.T ∝ $\frac{1}{\text{time of flow}}$

S.T → depend on impurity

↓

S.T ∝ soluble impurity

S.T ∝ No. particles of s.im

Q#

5g NaCl in H_2O > pure H_2O

1 mole NaCl in H_2O < 1 mole $MgCl_2$ in H_2O

$r \propto \frac{1}{\text{insoluble impurity}}$

organic

5g NaCl in H_2O > 5g octane in H_2O

Measured

* Torsian method * Capillary method * Staglommoter method / Drop method

relative property ← Viscosity → viscometer

* internal resistance to the flow of liquid
* property of Gas, liquid, Amorphous Solid
  - Liquid Crystal

Cause → drag force

Co-efficient of viscosity:

$F_D \propto \Delta V$ (difference in velocity)

$F_D \propto \frac{1}{\Delta x}$ (difference in distance)

$F_D \propto$ Area of Contact

$F_D \propto \frac{\Delta V \cdot A}{\Delta x}$ $F_D = \eta \frac{\Delta V \cdot A}{\Delta x}$

$\eta = \frac{F_D \cdot \Delta x}{\Delta V \cdot A}$

$$\eta = \frac{N \cdot m}{m/s} \times m^2$$

$$\eta = N \cdot \cancel{m} \times \frac{s}{\cancel{m^2}} \qquad \boxed{\eta = N s m^{-2}} \qquad \eta = Kg\, m s^{-2} \cdot s \cdot m^{-2}$$

S.I $\leftarrow \boxed{Kg\, m^{-1} sec^{-1}}$

* $1\ Kg m^{-1} sec^{-1} = 10$ poise

* 1 poise $= 10^{-1} \times 1\ Kg m^{-1} \cdot se^{-1}$

* $= 10^2\ g\, m^{-1} sec^{-1}$

Factors:

* $Vis \propto \Delta V$ (difference in velocity)

* vis $\propto$ Area of Contact

* $vis \propto \frac{1}{\text{distance blw layer}}$ * $Vis \propto \frac{1}{T}$ (liquid)

* $Vis \propto T$ (Gas)

* $Vis \propto$ density * vis $\propto$ IMF

* $Vis \propto H \cdot B$ / * $Vis \propto$ No# H·B

* vis $\propto$ No # drops from viscometer

$$\boxed{\eta_l = \frac{\text{density of liq}}{\text{density of } H_2O} \times \eta_{water}}$$

$\eta \longrightarrow$ depend on impurity

($\eta \propto$ soluble impurity)

$\left(\eta \propto \frac{1}{\text{insoluble impurity}}\right)$

Thermotropic L.C → sensitive to Temperature

also called Liquid Crystal

* Semi liquid * Solid liquid phase

Formation:

Solid → heat → liquid.

Solid → heat → intermediate → liquid

Melting point → called

Cloudy form → liquid Crystal

clearing tem

Property:

* exist b/w Mop & clearing temperature
* Liq. Cry → intermediate phase

Solid like proper (dic, q, in, specific)

* orientational order
* Anisotropic
* optical properties
* arrangement

liquid like pro

* weak positionall order
* S. Tension
* viscosity
* fluidity like liquid.

* Thermotrophic L.C :

Sensitive to Temperature